

Alternative Approaches to Manage Plant Parasitic Nematodes

Mohamed S. Khalil*

Central Agricultural Pesticides Laboratory, Agriculture Research Center, El-Sabaheya, Alexandria, Egypt

Agriculture is the main and basic source to human diet on the face of the earth; so many efforts were exerted to improve agricultural productions. And with human development and expansion of agricultural areas, many problems emerged such as the spread of pests and diseases, prompting human to try to limit the spread of these diseases, whether fungal diseases, bacterial or even nematodes, as well as all kinds and forms of insects, acari, weeds, snails, etc.

Human had began to use natural materials first from his environment such as rotenone, pyrethrum, nicotine, but its impact was characterized by weak in performance and volatility, so he resorted to use inorganic compounds included arsenic, copper, lead and tin salts which were highly toxic, in addition to borates, silicates and sulfur. But with the human needs, it was necessary to seek about other compounds which were effective and more stable, so he headed towards synthetic pesticides on which we are dependent till now. However, over time many problems appeared and showed the damages of these chemical pesticides on human health as well as on the surrounding environment.

Therefore, that was a motivation to search for effective alternatives against pests and various diseases at the same time with little and/or no impact on humans and the environment surrounding. New trends in the fields of pest control became very important to be a tool used in integrated pest management programs, integrated crop management and sustainable agriculture.

Integrated Pest Management programs based on the efficient compounds, safer to humans and the environment, specialized on target pests and diseases, do not accumulate and are readily degradable in the environment as defined by the terms of green chemistry.

In the last decade, the use of biorational pesticides became essential in control programs, especially with the expanded use of integrated pest management and sustainable agriculture. Recent statistics have shown in 2010 that the chemical pesticides usage were decreased by 1.3% yearly in the last decade (EPA), while the usage of bio-pesticides has been increased by 10% yearly, which represents 4.2% of the total pesticides usages.

Pests and diseases are considered to be the most serious problems faced by cultivated crops, and the plant parasitic nematodes (PPN) has been found to be the most common and destructive diseases in the recent period and one of the most difficult diseases to control. Moreover, the latest statistics showed that the estimated losses with PPN were \$118 billion worldwide. Therefore, it was necessary to try to find safe alternatives, cheap and effective to eliminate PPN.

PPN infesting several growing crops, such as vegetables and leguminous crops, oil crops, fiber crops, grain crops and fruit trees next to weeds which are the secondary host to parasitic nematodes. The most well-known species of root-knot nematode are *Meloidogyne incognita*, *M. javanica*, *M. arenaria* and *M. hapla* which are responsible for high economic damage to varied crops.

Otherwise, the common symptoms of the infestation with root-knot nematode are stunting, yellowing and wilting, but the major symptom is the gall formation in plant roots. The most harmful and predominant genus found were root-knot nematodes (*Meloidogyne*

spp), which include more than 150 species targeted by 48% of global nematicides.

There are certain methods to manage PPN in different crops. The conventional methods to manage PPN includes the soil fumigants (mixture of 1,2-dichloropropane and 1,3-dichloropropene, 1,3-Dichloropropene, Ethylene Dibromide, 1,2-Dibromo-3-Chloropropane, Chloropicrin, Metam-sodium, Dazomet, Methyl Isothiocyanate, Sodium Tetrathiocarbonate, Methyl Bromide and Methyl Iodide) and non-fumigant pesticides which follows carbamates group (Aldicarb, Aldoxycarb, Carbofuran and Oxamyl), and organophosphates group (Ethoprop, Fenamiphos, Cadusafos and Fosthiazate). The mechanism of both carbamates and organophosphates groups are cholinesterase inhibitor which prevents the breakdown of acetylcholine in the synapse.

On the other hand, unconventional methods which represent new trends and alternative approaches contained novel compounds that depend on biorational agents which included biopesticides such as abamectin that follow avermectin group. Abamectin is a mixture of macro-cyclic lactones metabolites produced by a natural fermentation of the bacterium *Streptomyces avermitilis*, which are responsible for the production of avermectins.

Abamectin is a mixture of avermectins containing more than 80% avermectin B_{1a} and less than 20% avermectin B_{1b}. The avermectins are used as an insecticide, acaricide and nematicide on vegetables, fruits and field crops. The toxicity of abamectin is based on its specific action on γ -aminobutyric acid (GABA) thus blocking the nervous signal transmission at the neuromuscular junctions, leading to paralysis and death.

Beneficial fungi Arbuscular Mycorrhiza Fungi (AMF) are considered as ecologically important symbiotic fungi with plants in the land ecosystem. Mycorrhizas are commonly divided into ectomycorrhizas and endomycorrhizas. The largest genus of the arbuscular mycorrhizal fungi is *Glomus* spp. The main target of AMF is to help plants to capture nutrients such as phosphorus, sulfur, nitrogen and micronutrients from the soil.

Also, AMF increase chitinase activity and β -1,3-glucanase in roots, as well as enhance the host tolerance and augmenting resistance, changes in root exudates which decrease attraction of nematode and attracted the plant growth promoting bacteria and an increase in phenols in roots.

*Corresponding author: Mohamed S. Khalil, Central Agricultural Pesticides Laboratory, Agriculture Research Center, El-Sabaheya, Alexandria, Egypt, E-mail: melonema@gmail.com

Received December 19, 2012; Accepted December 28, 2012; Published January 02, 2013

Citation: Khalil MS (2013) Alternative Approaches to Manage Plant Parasitic Nematodes. J Plant Pathol Microb 4: e105. doi:10.4172/2157-7471.1000e105

Copyright: © 2013 Khalil MS. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Several microbial pathogens are effective against nematodes. These microbial agents include the bacteria such as *Pasteuria penetrans*, *Bacillus* spp, *Pseudomonas fluorescens* and *Burkholderia cepacia*. Furthermore, the antagonistic fungi can be divided into predacious fungi (*Arthrobotrys*, *Dactylaria*, *Dactylella*, *Monacrosporium*), endoparasites fungi (*Acremonium*, *Fusarium*, *Gliocladium*, *Hirsutella*, *Nematophthora*, *Paecilomyces*, *Penicillium*, *Phoma*, *Pochonia*, *Catenaria* and *Trichoderma*) and fungi produce antibiotics and toxins (*Aspergillus*, *Trichoderma*, *Penicillium* and *Myrothecium*). Those mentioned microbial agents are the most studied and the commonly applied in PPN control worldwide, as well as have commercial productions in some countries as USA, Canada and India.

Botanical pesticides are also used as nematicide like neem oil which is considered vegetable oil pressed from the fruits and seeds of the neem tree *Azadirachta indica*. Neem oil contains many triterpenoid compounds; the main component is Azadirachtin for which the first total synthesis was completed in 2007. Besides, there are the essential

oils extracted from aromatic and culinary herbs which have shown promise as potential sources for new nematicides (carvacrol and thymol).

Soil amendments for nematode control is one of the non-traditional methods, which include organic materials (compost, green manures, and organic mulches), oil cakes (neem cake and castor cake) and chitinous wastes such as crushed shells of crustaceans (shrimp and crab). Also, cover crops such as Cowpea, Sunn Hemp, Sorghum, Marigold, Velvet bean, Rye and Bahia grass, Castor beans, Chrysanthemums and Sesame suppress nematodes through chemical residues, especially when grown and tilled into the soil.

Regarding the last decade, the Entomopathogenic nematodes under the families Steinernematidae and Heterorhabditidae are used against soil insects. The ability of Entomopathogenic nematodes to suppress the populations of plant-parasitic nematodes has been discovered, but has not received enough attention until now.